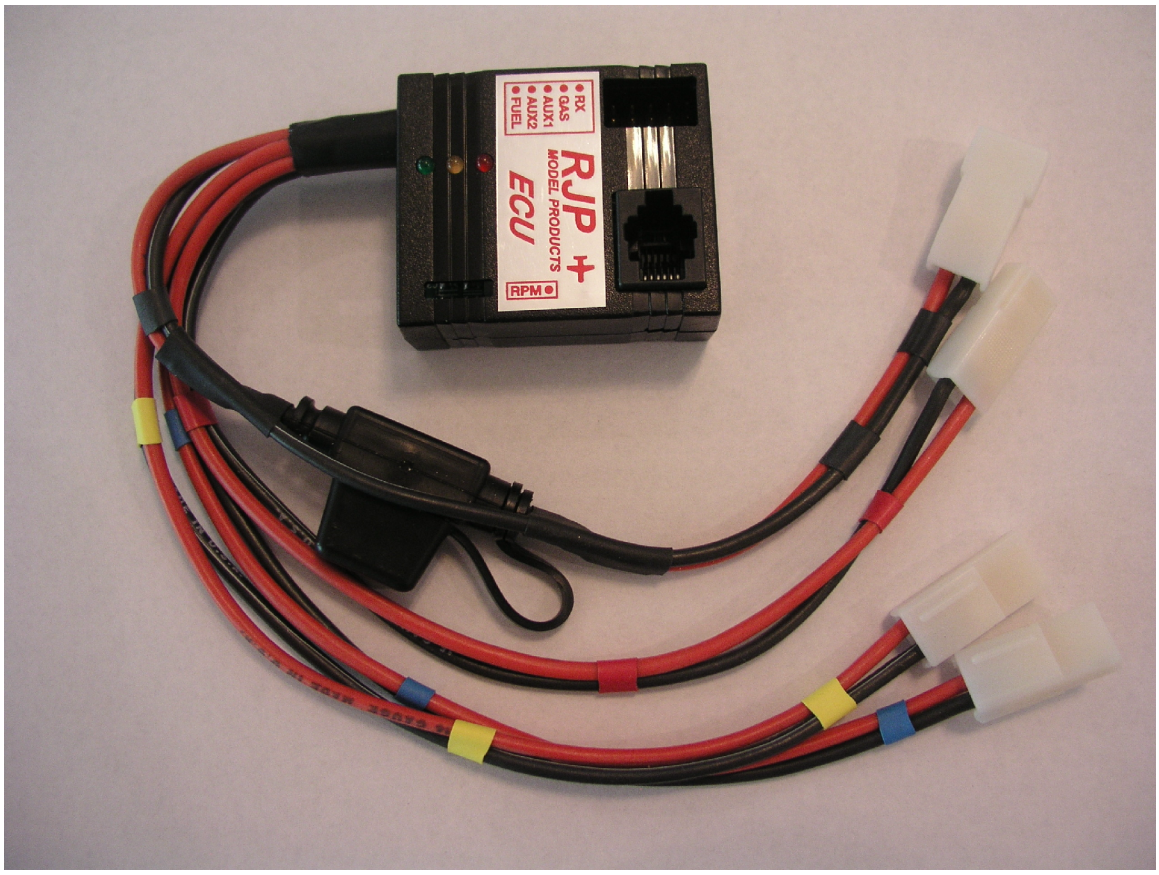
RJP Model Products

ECU



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RJP Model Products ECU Manual Update Sheet for R03B Level Software

The R03B level software for the RJP Model Products ECU contains many engine control software improvements that will not be apparent to the average turbine operator.

The following list describes the changes that the turbine operator will need to know

1. The turbine will ramp up to 70K rpm for the 750/1000/RTI engine types and to 80Krpm for the 500 types and then come back down to the idle rpm during the fuel ramp cycle. This has been added to do a better job of learning the pump characteristics for the first engine runup.

2. An “AUTO COOL TEMP” operator parameter adjustment has been added to the end of the operator parameter adjustment menu to adjust the temperature that the auto cool down cycle cools the engine down to.

Some suggestions for “GLOW PLUG V” engine parameter setup

There are a wide variety of battery types and plug types that affect the glow plug voltage setting in the operator parameter menu. The brightness of the plug can be viewed by running the “GLO” test with the plug removed from the engine and connected to the plug leads. When the “GLO” button is HELD DOWN, the plug will be energized for the same time period (.6 sec) as used when the engine is started and the brightness can be viewed. The element should be approaching a white color at the hottest spot for the best temperature.

To best minimize the exposure of blowing plugs with a setting that is too high for the plug type and battery type used, start with a lower setting and gradually bring up the setting. The best setting is the lowest setting that will reliably ignite the engine.

The default setting is 0.70v and the range of settings for the many plug types and battery types is from 0.5v to 1.2v. The lower settings are used for higher resistance plugs (thinner element wire) and lower resistance batteries (Nicad,LIPO) and the higher settings are used for lower resistance plugs(heavier element wire) and higher resistance batteries(LI).

Safety Warning

This manual describes the operation of the RJP Model Products ECU when used with the RAM 1000, RAM 500, or RTI 2800 turbine engines. It does not address the safety issues involved with the running of these turbine engines. It is the responsibility of the turbine operator to completely understand ALL of the safety rules associated with operating the turbine engine as spelled out in the Operating Manual for the turbine engine that the ECU is being used with.

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Introduction

The RJP ECU is a new ECU designed and built by RJP Model Products. It is an upgraded replacement for the RAM ECU and FTE ECU. From now on I will refer to both the RAM and FTE ECU's as the RAM ECU. They are the same ECU with different ECU/Display Terminal labels, different software version level names, and different engine names displayed in some Display Terminal menus.

NOTE: RJP Model Products designed the RAM/FTE ECU and Data Terminal (Start Box) and has built all of the RAM/FTE ECU's and Data Terminals

The RJP ECU uses a new more powerful microprocessor in the same hardware package with some circuit board modifications, component modifications, and totally new turbine control software. Although the turbine control software is totally new, the menus and operator interfaces have been kept similar to the RAM ECU as much as possible for obvious reasons.

The RJP ECU can be used with any RAM or FTE Data Terminal without any modifications. The Data Terminal contains the display and associated driver circuits but does not contain a microprocessor or software.

The RJP ECU turbine control software utilizes total closed loop control based on rpm at all throttle settings. The target rpm is set by the throttle stick position with low stick position set to the "low rpm" operator parameter setting and the high stick position set to the "hi rpm" operator parameter setting. In simple terms, the main function of the turbine control software is to control the pump voltage to bring the actual turbine rpm to the desired target rpm at a controlled rpm change rate to keep the turbine from overheating or stalling.

The new control software has a built throttle curve designed to give throttle control similar to the RAM ECU. The RAM ECU automatically gave a desirable throttle curve because it used open loop control between low and high throttle, setting the pump voltage based on the throttle stick position. When using closed loop control based on rpm, without a built in throttle curve, the power at mid stick position is too low requiring transmitter throttle curve programming to give more power in the low and mid stick positions.

The RJP ECU can be setup (factory setting) to run the RAM 500, RAM 1000, or RTI2800 type engines.

New Features

The RJP ECU incorporates additional functional tests in the **Receiver Control Menu** and the **Manual Control Menu**. Button #2 on the data terminal selects the test to be performed while the label for the test is displayed next to button #3. The test is performed by pressing button #3, with the test identifier listed next to the button. The tests include running the start motor, running the pump (also prime function), actuating the fuel solenoid, actuating the gas solenoid, and driving the glow plug with the same voltage and time duration as used in the start up sequence. These tests are performed in the main start up menus and they eliminate the need to initiate a start up sequence to test some of the devices. A more detail description of these tests is located in the **Receiver Control Menu Buttons** section
All of the operator parameters values now set a higher value with a higher parameter value to eliminate some confusion with the RAM software levels. The gas adjust is now a value from 1 to 10 with a higher number setting a higher amount of gas. The plug setting is now actual plug voltage (1.00) with a higher value setting a higher plug voltage. Pump PW (Pulse Width) is now displayed as pump voltage (2.50) as well as Pump PW (350), the pump start PW (Pulse Width) is now start pump voltage (0.32), and the prime PW (Pulse Width) is now prime pump voltage (1.00).

The RJP ECU also has additional operator parameter settings such as up/down times for the low, medium, and high rpm ranges but will only allow the up/down times to be slowed down. This is a cure for compressor stalling due to altitude or other problems causing the engine to quit with the normal up/down ramp times. The start motor starting voltage can also be set to compensate for a tight engine preload, cold conditions, or a weak start motor, It also can be set for full voltage when using the original start motor on the RAM 750/1000 types. A more detail description of all of the operator parameter settings is located in the **Operator Parameter Settings Menu Parameters** section.

The RJP ECU can be reliably used with Li-ion batteries such as Duralites. I have been using Duralites with my new RJP ECU for a year now and get at least 8 flights. I also use them for my receiver. They will not work reliably (not many flights) with the current RAM ECU even with the C02C or C03 software because LI-ION batteries have a higher internal resistance than Nicads. When the start motor first comes on it draws a very high current and the voltage to the microprocessor drops below its threshold operating voltage and the microprocessor resets. This can be seen by trying to start the turbine in Manual mode and when the start motor comes on, the ignition cycle will stop and the ECU will then be in Receiver mode. The ECU comes back up in Receiver mode because the Microprocessor has reset and this is the mode that the ECU comes up in when powered up. The RJP ECU uses a new, more powerful, microprocessor that will not reset when the start motor first comes on because it will work at a much lower voltage.

Connecting ECU to Turbine System

1. Connect the receiver lead with a male plug at both ends between the receiver throttle servo output to the ECU input connector pins labeled “RX”. Make sure the brown wire (GND) is towards the outside edge as marked with the red dot.
2. Connect the gas solenoid lead to the ECU input connector pins labeled “GAS”. Make sure the brown wire (GND) is towards the outside edge as marked with the red dot.
3. Connect the fuel solenoid lead to the ECU input connector pins labeled “FUEL”. Make sure the brown wire (GND) is towards the outside edge as marked with the red dot.
4. Connect the RPM Sensor lead to the ECU input connector pins labeled “RPM”. Make sure the brown or black wire (GND) is in the direction marked with the red dot.
5. Connect the Start Motor lead to the ECU cable with the red bands on the leads.
6. Connect the fuel pump lead to the ECU cable with the yellow bands on the leads.
7. Connect the glow plug lead to the ECU cable with the blue bands on the leads.
8. Connect the battery lead to the ECU cable with the black bands on the leads. The ECU battery cable will have the opposite polarity connector so this lead can not be connected to anything other than the battery.
9. Connect the EGT probe connector in the slot at the end of the ECU. The connector is orientated such that the wider of the 2 connector blades is towards the center of the ECU.
10. The telephone type (RJ11) cable from the Start/Display Terminal plugs into the RJ11 connector on the ECU.

IMPORTANT NOTE: Only use RAM solenoids or the ECU may be damaged. The Ram solenoids have a built in transient suppression diode and if another type solenoid without the built in diode is used, the solenoid driver circuit in the ECU could be damaged.

Optional Fuse

The RJP ECU can be fitted with an optional fuse holder in the ECU battery lead. The fuse is an ATM miniature automotive blade fuse. I strongly recommend the fuse because it will protect the ECU components and circuit board if there is a short in any of the components connected to the ECU leads including the start motor, fuel pump, or glow plug. When a short occurs with any of these leads, the mosfet driver device needs replacing and often the circuit board is damaged. The size of the fuse can either be 10A or 15A but NEVER any larger. The 10A fuse is large enough. The most current drain occurs when the start motor is first turned on during the “AIR” test, Cool Down cycles, or turbine start-up. The fuse will never blow after the engine is started up unless something is shorted at this time. The fuse holder and fuse combination is very reliable connection between

the battery and ECU. As long as a 10A or 15A fuse is used in the fuse holder, the ECU driver devices will not be damaged with an external short.
WARNING – If the fuse is blown, only replace with another fuse and do not attempt to jumper the fuse holder with a wire or other device. This will defeat the purpose of the fuse especially if the fuse had blown because of a possible shorting problem.

Turning the ECU ON

The ECU is turned on by either turning the receiver on **OR** by plugging in the Start/Data Terminal. If the receiver is plugged into the ECU and turned on, the ECU will not turn off if the Start/Data Terminal is unplugged. Likewise if the receiver is turned off while the Start/Data Terminal is plugged in, the ECU will not turn off.

If the Start/Data Terminal is plugged in and the receiver is turned off, the receiver voltage (**"RX=0.43"**) in the **Receiver Control Menu** or **Manual Control Menu** will show a voltage less than 0.50 volts. When the receiver is turned on, the receiver voltage (**"RX=6.25")** will show the actual receiver battery voltage.

Warning – If you are using a regulator between the receiver battery and the receiver, the ECU will show the regulated voltage and not the voltage of the battery. The receiver battery could be down low but you will not be able to view the actual battery voltage.

The **Receiver Control Menu** will be on the display when the ECU is first powered up.

A detail description of all the menus is located later in this manual.

PLEASE READ THE COMPLETE MANUAL BEFORE STARTING THE TURBINE.

The detailed descriptions of the operator parameter settings in the **Operator Settings Menu Parameters** and the detailed descriptions of the error codes in the **Operator Setup Menu Error Messages** section, the **Receiver Control Menu Error Messages** section, and the **Manual Control Menu Error Messages** section will be a big help in diagnosing problems associated with turbine startup and for diagnosing problems associated with a turbine shutdown in any of the turbine cycles.

Setting up and Testing the Fail-Safe System

1. The failsafe system is designed to shut the turbine down if the transmitter/receiver goes into failsafe mode for a preset period of time. The AMA Turbine rules state that the ECU must be shut down if the transmitter/receiver stays in a failsafe mode for a period of time equal or greater than 2 seconds. The failsafe time for the RJP ECU is set in the **operator Parameter Settings Menu**. A detail description of this parameter setting is in the **Operator Parameter Settings Menu Parameters** section.

2. The transmitter must be set up to give a smaller pulse width output when the transmitter/receiver is in the fail safe mode than when the transmitter is in the turbine kill mode (low throttle and low throttle trim). This is accomplished by the following sequence:

    - Set the transmitter throttle ATV (hi and lo) to 125%
    - Put the throttle stick at the lo position and the throttle trim control at the low position
    - Store these settings in the transmitter fail safe menu
    - Set the transmitter throttle ATV settings back to 100%
    - The transmitter is now setup for failsafe and does not have to be changed again

3. The next step is to teach the ECU as described in the **Teach Procedure Menu** section. This will teach the transmitter the transmitter pulse width values for hi throttle, low throttle, and kill (low throttle with low throttle trim) to the ECU. When teaching the HI throttle and Low throttle positions the trim can be set either the Hi position or Mid position. I recommend always leaving the trim set at Hi position except for the throttle kill. Whichever position you choose for the throttle trim (Hi or Mid), you must ALWAYS use this position (except for throttle kill) for the Teach process and when running the engine.

4. The failsafe system can now be tested for correct operation by going back to the **Teach Procedure Menu** and checking the transmitter pulse width values. If you go to the **Teach Procedure Menu** and do not do any saves, the transmitter throttle pulse width will be displayed on the first line after **"THROTTLE HI"**. After the readings have been verified the **MNU** button will take you back out of the **Teach Procedure Menu** back to the **Receiver Control Menu** without any changes to the Teach parameters already saved.

    - Move the transmitter throttle to the Hi position with the throttle trim at mid or hi position (whichever method you have chosen) and view the transmitter pulse width reading next to **"THROTTLE HI"**. It will be about 1900 (1900us or 1.9ms) or 2000 depending on where the trim is set.

- Move the transmitter throttle to the Lo position with the throttle trim at mid or hi position (whichever method you have chosen) and view the transmitter pulse width reading next to **"THROTTLE HI"**. It will be around 1100 or 1200 depending on the trim setting.

- Keep the transmitter throttle at the LO position and move the throttle trim to the Lo position for the KILL signal. The transmitter pulse width reading should be around 100 to 200 below the value for the previous Lo throttle reading. The difference will be greater if the Hi throttle trim method is used. The difference should be at least 75 for safety margin.

- Now turn the transmitter OFF to test for the transmitter Failsafe pulse width value. The value will be around 100 below the previous KILL value and should be at least 75 for safety margin.

5. A final test for the failsafe system is to run the engine on the ground and turn the transmitter off/on a number of times for a period of time less than 2 seconds and then turn the transmitter off. The engine should shut down after 2 seconds. Wait for the cool down cycle to complete or at least for the first cool down cycle to complete and go to the **Operator Setup Menu** to view the shutdown cause error message, the Hit Count **("HC=")** value and the Hit Time **("HT=")** value. The error message should be **"RUN-FAIL SAFE"**, the Hit Count should be the number of times you shut the transmitter off including the last time, and the Hit Time should be the total time you had the transmitter off including 2 seconds for the last time.

WARNING

If the failsafe is set up correctly, the turbine will be shutdown immediately using the KILL condition (low throttle and low throttle trim) and the error message will be **"RUN-TX SHUTDOWN".**

The turbine will shut down within 2 seconds if the failsafe condition occurs for a 2 second time period and the error message will be **"RUN-FAIL SAFE".**

IF the failsafe is NOT set up properly, the turbine will shut down **IMMEDIATELY** if the failsafe condition occurs for **ANY** time period and the error message will be **"RUN-TX SHUTDOWN"**.

The turbine will also be shutdown immediately using the KILL condition (low throttle and low throttle trim) and the error message will be **"RUN-TX SHUTDOWN".**

If the failsafe is not setup correctly, the turbine will shutdown IMMEDIATELY when a failsafe condition occurs and you will not know that a failsafe condition occurred because the error message will be **"RUN-TX SHUTDOWN"**

Preparing for Turbine Startup

1. Make sure that the turbine and ECU are connected up properly

2. Make sure the Transmitter Failsafe is set up and the ECU Teach has been completed

3. Fill the gas container with Coleman Powermax. The gas solenoid can be tested at this time if desired by selecting the **GAS** test. The **GAS** test is selected by pressing the **TST** button (button #2) until **"GAS"** is displayed next to button #3. The GAS solenoid will open/close at a high rate to control the amount of gas flow set by the **GAS ADJUST** operator parameter setting as long as the **GAS** button is pressed. You will be able to hear the gas solenoid pulsing and you will be able to see the movement of the gas in the gas line at the output of the gas solenoid.

4. Make sure there is fuel in the fuel tanks and the hopper tank or UAT is filled.

5. Prime the pump so that fuel is flowing all the way to the engine. The **PMP TEST** is selected by pressing the **TST** button until **"PMP"** is displayed next to button #3. The fuel solenoid will open and the fuel pump will pump fuel at the rate set by the **PRIME PUMP V** operator parameter setting as long as the **PMP** button is pressed.

6. The start motor can be tested at this time if desired by selecting the **AIR TEST**. The **AIR TEST** is selected by pressing the **TST** button until **"AIR"** is displayed next to button #3. The start motor will run as long as the **AIR** button is pressed.

7. The glow plug can be tested at this time if desired by selecting the **GLO TEST**. The **GLO TEST** is selected by pressing the **TST** button until **"GLO"** is displayed next to button #3. The glow plug will light with a plug voltage value set by the **GLOW PLUG V** operator parameter for the same duration of time (0.6 sec) during the engine startup if the **GLO** button is held down. The brightness of the glow plug can be observed during this test by removing the glow plug and cable from the engine and connecting the leads to the plug.

8. Make sure the filament in the glow plug is pulled out such that several windings extend out from the bottom of the plug housing.

9. Make sure the transmitter throttle control is set to throttle low position.

Turbine Startup

Initiating the Turbine Startup Sequence

The turbine can be started up and run either by using the **Receiver Control Menu** or the **Manual Control Menu**. The turbine startup can only be initiated if the Green LED is flashing and there is no error message in the **Receiver Control Menu** or **Manual Control Menu**. If the Red LED is flashing there will be an error message displayed describing the condition that is not allowing the initialization of the startup procedure. These error messages and causes are described in detail in the **Receiver Control Menu Error Messages** and **Manual Control Menu Error Messages** sections.

NOTE: The LED's are located on the ECU and all messages are displayed on the Start/Data Terminal.

IMPORTANT REMINDER – Any error messages that apply to conditions that do not allow startup are displayed in either the **Receiver Control Menu** or the **Manual Control Menu** depending on the startup method**.** A detail description of these errors is located in the **Receiver Control Menu Error Messages** and **Manual Control Menu Error Messages** sections**.**
Any error messages that result from a turbine shutdown in any of the cycles (Ignition, Fuel Ramp, or Running), are displayed in the **"Operator Setup Menu".** These error messages and causes are described in detail in the **Operator Setup Menu Error Messages** section**.** There may also be an error message in the **Receiver Control Menu** or **"Manual Control Menu"** but these messages apply to the current conditions that do not allow a new startup and do not apply to the current shutdown problem.

IMPORTANT SUGGESTION – I recommend that the Start/Data Terminal **always** be used during the turbine start-up process to monitor the turbine parameters. Record the Pump Voltage while the Turbine is running at Idle (**LOW RPM**) and at full throttle (**HIGH RPM**) and compare these values to the current start-up values.

I also recommend to run the turbine up to full throttle once before takeoff to make sure these values are reasonable. If the fuel system has clogged up since these values were checked, the turbine may not ever get to full power during the flight. If the turbine is run up to full throttle once before the flight, you will verify that the fuel system is ok and that full throttle RPM is obtainable. This also insures normal throttle response during the takeoff. The throttle response is slower until the fuel pump strength is learned during the first run-up. If the full **HIGH RPM** is never reached while the stick is at full throttle, the pump strength will not be learned and the throttle response will be slower during the flight.

Receiver Control Startup Initialization

The **Receiver Control Menu** is used to start up and run the turbine using receiver control and it is the mode used for an actual flight. The Start/Data Terminal can either be plugged in or not. I suggest that the Start/Data terminal be used for all startups to verify that the engine is operating properly by viewing the parameters during the startup process. When the Start/Data Terminal is plugged in, the startup procedure can be initiated by either pressing the **RUN** button or moving the throttle stick up and down (full travel) 3 times within a four second period. If the Start/Data Terminal is not plugged in, the startup procedure is initiated by moving the throttle stick up and down (full travel) 3 times within a four second period.

Manual Control Startup Initialization

The **Manual Control Menu** is used to startup and run the turbine from the Start/Data Terminal without the use of the transmitter or receiver. The startup procedure is initiated by pressing the **RUN** button. When using manual control, the turbine is controlled by using the buttons on the Start/Data Terminal.

Turbine Ignition On Cycle

When the turbine startup sequence is initialized, the **Ignition On Menu** will be displayed with the message “IGNITION ON” displayed. The red LED will be on solid during the Ignition On cycle. The RPM and EGT parameters are displayed during the Ignition On cycle. The Ignition On cycle can be aborted at any time by pressing the “OFF” button or by initiating the transmitter KILL condition (low throttle and low throttle trim) in Receiver control mode.

The turbine will first run up to 5K RPM to test the rpm sensor and to verify that the signal level from the rpm sensor is at a safe level for reliable turbine operation at all rpm’s. If the rpm tests fail, the startup procedure will stop, the **Receiver Control Menu** or **Manual Control Menu** will be displayed, and an error message will be displayed in the **Operator Setup Menu.**

If the rpm tests pass, the engine coasts down to 1K for the RAM 500 type and down to 2K RPM for the RAM 1000/RTI/2800 . The glow is then turned on for a 0.6 second period, then the gas solenoid is activated, and the start motor is turned on. If an EGT rise is detected and the RPM is above 5K, the fuel ramp cycle will start. If the EGT does not rise in an allotted time, two more attempts will be made to ignite and get an EGT raise. The turbine will be shut down if the third attempt fails.

If the turbine is shut down for and reason during the Ignition On cycle including a shutdown by the software program, the ECU will return to the **Receiver Control Menu** or the **Manual Control Menu** depending on the current control mode, and the error message for the shutdown will be displayed in the “Operator Setup Menu”

Reminder – A detailed description of the error that caused the turbine to shut down is contained in the **Operator Setup Menu Error Messages** section based on the error message shown in the **Operator Setup Menu**.

Turbine Fuel Ramp Cycle

When the Fuel Ramp cycle is started, the **Fuel Ramp Menu** will be displayed with the message “RAMPING” displayed. The red LED will turn off and the yellow LED will be on during the Fuel Ramp cycle. The RPM, EGT, ECU battery voltage, pump voltage, and pump PW will be displayed in this menu. The turbine startup can be stopped at any time during the Fuel Ramp cycle by pressing the “OFF” button or by initiating the transmitter KILL condition (low throttle and low throttle trim) if in Receiver control mode.

During the Fuel Ramp cycle, the pump voltage will be increased at a set rate while monitoring RPM, EGT, and ECU battery voltage. When the RPM reaches the idle rpm set by the “LOW RPM” operator parameter, the turbine will go into the Running cycle.

If the turbine is shut down for and reason during the Fuel Ramp cycle including a shutdown by the software program, the ECU will return to the **Receiver Control Menu** or the **Manual Control Menu** depending on the current control mode and the error message for the shutdown will be displayed in the **Operator Setup Menu.**

Reminder – A detailed description of the error that caused the turbine to shut down is contained in the **Operator Setup Menu Error Messages** section based on the error message shown in the **Operator Setup Menu**.

Turbine Running Cycle (Receiver Control)

When the Running cycle is started while in the Receiver Control mode, The **Running Menu (Receiver Control)** will be displayed. The yellow LED will turn off and the green led will be on solid during the Running cycle. The RPM (**R**), **EGT**, Transmitter pulse width (**SPW**), Target Rpm (**TG**), ECU battery voltage (**ECU**), pump voltage (**PV**), and pump pulse width (**PW**) parameters will be displayed.
The Target RPM is determined by the Transmitter throttle pulse width (stick position), the built in throttle curve, the low throttle rpm value set by the **LOW RPM** operator parameter, and the high throttle rpm value set by the **HI RPM** operator parameter.
The engine will run at idle with the target rpm and actual rpm equal the **LOW RPM** setting as soon as the running cycle has started. As the throttle stick is raised the Target rpm will increase and the engine control software will increase the pump voltage at a controlled rate and the actual rpm will match the target rpm after a short period of time. The engine will respond a little slower than normal until the throttle has been raised to the full position and the actual rpm has risen to the same value as the target rpm (**HIGH RPM** value) the first time. At this time the yellow LED on the ECU will come on and the **"PVHISET"** message will be displayed on the data terminal. At this point the ECU software has calibrated itself as far as pump strength is concerned and the engine up and down response will be normal. This slower response before the "**PVHISET"** message is needed before calibration to make sure the engine does not overshoot the hi rpm the first time up due to a new pump with unknown strength.

The turbine can be shut down manually at any time during the Running cycle by pressing the **OFF** button or by initiating the transmitter KILL condition (low throttle and low throttle trim) if in Receiver control mode.

If the turbine is shut down for and reason during the Running cycle including a shutdown by the software program, the ECU will return to **Receiver Control Menu** and the error message for the shutdown will be displayed in the **Operator Setup Menu.**

Reminder – A detailed description of the error that caused the turbine to shut down is contained in the **Operator Setup Menu Error Messages** section based on the error message shown in the **Operator Setup Menu**

Reminder – When the turbine is manually shut down at the end of the flight using the KILL condition (low throttle and low throttle trim), the **"RUN-TX SHUT DOWN"** error message will be displayed in the **Operator Setup Menu**. This is the normal way to shut the turbine after a flight.

Turbine Running Cycle (Manual Control)

When the Running cycle is started while in the Manual Control mode, The **Running Menu (Manual Control)** will be displayed. The yellow LED will turn off and the green led will be on solid during the Running cycle. The RPM (**R**), **EGT**, Manual power setting (**PWR**), Target Rpm (**TG**), ECU battery voltage (**ECU**), pump voltage (**PV**), and pump pulse width (**PW**) parameters will be displayed.

The Target RPM is determined by the Start/data Terminal buttons, the built in throttle curve, the low throttle rpm value set by the **LOW RPM** operator parameter, and the high throttle rpm value set by the **HI RPM** operator parameter.

The engine will run at idle with the target rpm and actual rpm equal the **LOW RPM** setting as soon as the running cycle has started. The target rpm is now controlled by the **INC**, **DEC**, and **FUL** buttons.

The **INC** button increments the Target RPM in 5% steps and the **DEC** button decrements the Target RPM in 5% steps. The **PWR** reading displays the percent of the total rpm spread between **LOW RPM** and **HIGH RPM** that the Target RPM is currently set at. The percent values are displayed as **" LOW, 5 , 10 , 15 ----- 85, 90, 95, HI."**

IF the **"PWR"** value is at **"LO"** and the FULL button is pressed, the target rpm will jump to **HIGH RPM** and the **"PWR"** value will jump to **"HI"**. The engine will then go to full power.

IF the **"PWR"** value is at **"HI"** and the **FULL** button is pressed, the Target RPM will jump to the **LO RPM** value and the **"PWR"** value will jump to **"LO"**. The engine will then go to idle.

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As Target rpm is increased the engine control software will increase the pump voltage at a controlled rate and the actual rpm will match the target rpm after a short period of time. The engine will respond a little slower than normal until the "**PWR"** is at **"HI"** and the actual rpm has risen to the same value as the target rpm (**HIGH RPM** value) the first time. At this time the yellow LED on the ECU will come on and the **"PVHISET"** message will be displayed on the data terminal. At this point the ECU software has calibrated itself as far as pump strength is concerned and the engine up and down response will be normal. This slower response before the **"PVHISET"** message is needed before calibration to make sure the engine does not overshoot the hi rpm the first time up due to a new pump with unknown strength.

The turbine can be shut down manually at any time during the Running cycle by pressing the "OFF" button.

If the turbine is shut down for and reason during the Running cycle including a shutdown by the software program, the **Manual Control Menu** will again be displayed and the error message for the shutdown will be displayed in the **Operator Setup Menu**

Reminder – A detailed description of the error that caused the turbine to shut down is contained in the **Operator Setup Menu Error Messages** section based on the error message shown in the **Operator Setup Menu**.

Turbine Shutdown and Cool Down Cycle

It is best to let the turbine run at idle or just above idle for about 30 seconds before shutting down.

The Start/Data Terminal can be plugged back into the ECU after a flight if desired to view the turbine operation before, during, and after shutdown.

When the turbine is shut down it will coast down to 1K rpm and start the Cool Down cycle. The Cool Down cycle will cycle the turbine between 1K rpm and 5K rpm as long as the EGT temperature is above 180 degrees C. The Cool Down cycle is mainly for the purpose of cooling down the engine to keep the interior of the airplane cooler.

While the turbine is coasting down to 1K rpm after shutdown and before the first cool down cycle, the spool down time is being measured. At the time the turbine reaches 1K rpm, the spool down time and all the other parameters from the run are saved in memory. The run parameters are also saved in the History file for each flight. The Previous run data is displayed in the **Operator Setup Menu** until the next turbine run, and the run data for all previous flights can be viewed in the **History Menu**.

WARNING

If the Start/Data Terminal is plugged into the ECU during the Turbine shutdown, DO NOT push any buttons until the first cool down cycle or none of the data for that turbine run will be saved.
After the first cool down cycle you can go to the **Operator Setup Menu** to view the run data but you will interrupt the cool down cycle, which will not be running while in the **Operator Setup Menu**. If you return to the **Receiver Control Menu** or the **Manual Control Menu** the cool down cycle will resume. At any time you are in the **Receiver Control Menu** or the **Manual Control Menu** and the EGT temperature is above 180 degrees, the cool down cycle will be running.

The saved run/flight data includes run time, max EGT reading, spool down time, max fuel pump voltage, number of failsafe hits, total time in failsafe mode, and Error Messages. If the KILL condition (low throttle and low throttle trim) was

used to shut down the turbine, the error message will be **"RUN-TX SHUTDOWN",** and in this case it is not really an error.
If the turbine was shut down automatically during the run by the ECU, the error message will indicate the reason for the shutdown.
A detailed description of each of the other possible error messages that resulted in a turbine shut down during the startup or run cycles is located in the **Operator Setup Menu Error Messages** section.

Startup Failure Solution Guidance

Fail RPM Test

If any of the RPM tests fail during the first run-up in the ignition cycle the ECU will return to the startup control menu for the current startup mode (Receiver or Manual). The error message in the **Operator Setup Menu** will be **"IGN-NO RPM", "IGN-LOW RPM"**, or **"IGN-SENSOR LOW"**. These errors are indicating that there is something wrong with the RPM sensor or the signal level from the sensor is below the level to guarantee reliable RPM readings at all RPM's.
See the **Air Test** description in the **Receiver Control Menu Control Buttons** section and the **"IGN-NO RPM"**, **"IGN-LOW RPM**", and **"IGN-SENSOR LOW"** detailed error descriptions in the **Operator Setup Menu Error Messages** section for solutions.

Failure to Ignite the GAS

If the gas fails to ignite after 3 attempts in the Ignition cycle, the ECU will return to the startup control menu for the current startup mode (Receiver or Manual). The error message in the **Operator Setup Menu** will be **"IGN-NO IGNITION"**. This is caused by either not enough gas or not enough heat in the glow plug.

Test the glow and gas solenoid as described in the previous **Preparing for Turbine Startup** section.

See the detail description of the operator parameter settings for the **GLOW PLUG V** and **GAS ADJUST** operator parameters in the **Operator Parameter Settings Menu Parameters section** for adjustment suggestions.

Fuel Ramp failures

If the ECU returns to the startup control menu for the current startup mode (Receiver or Manual) during the Fuel Ramp cycle with the **"RMP-MTR Timeout"** error displayed in the **Operator Setup Menu,** the RPM did not raise to the start motor turn off RPM within a 30 second period. This is usually caused by not enough fuel getting to the turbine at a fast enough rate. The fuel system may be clogged, the fuel pump may be weak, the Pump Start Voltage may be too low, the Gas Adjust may be too low, or the start motor may be weak.

See the detailed **"RMP-MTR Timeout"** error description in the **Operator Setup Menu Error Messages** section and the detailed descriptions of the **Start Pump V** and **Gas Adjust** operator parameters in the **Operator Parameter Settings Menu Parameters section** for solution suggestions.

Other Failures

If the turbine shuts down during any of the turbine cycles (Ignition, Fuel Ramp, or Running), the ECU will return to the startup control menu for the current startup mode (Receiver or Manual). There will always be an error message in the Operator Setup Menu for the cause of the shut down.

See the detailed error description in the **Operator Setup Menu Error Messages** section for a detailed explanation of the error and hints for the resolution of the problem.

Main Menu Organization

Receiver Control Menu
Operator Setup Menu
- **Teach Procedure Menu**
- **Operator Parameter Settings Menu**
- **Data Menu**
  - **History Menu**

Manual Control Menu

The Receiver Control Menu is used to start up the engine when running the turbine with transmitter/receiver.

The Operator Setup Menu displays run data and error messages from the previous run. This menu also allows access to the **Teach Procedure Menu**, **Operator Setup Settings Menu**, and **Data Menu**.

The **Teach Procedure Menu** is used to teach the ECU the transmitter pulse widths for the transmitter high throttle, low throttle, and kill condition (low throttle with low throttle trim).

The **Operator Parameter Settings Menu** is used to set the operator parameters.

The **Data Menu** displays turbine type, # of cycles, total engine time, ECU serial number, software version, and max rpm data. This menu also allows access to the **History Menu**.

The **History Menu** displays run data and error messages from the previous 256 engine runs.

The **Manual Control Menu** is used to start up the engine when running the turbine with Start/Data Terminal.
The **Receiver Control Menu** will be on the display when the ECU is powered up. The four identifiers on the right side of each menu describe the current function of the control buttons.

Turbine Operational Menu Organization

These menus are displayed during the startup and running cycles of the turbine.

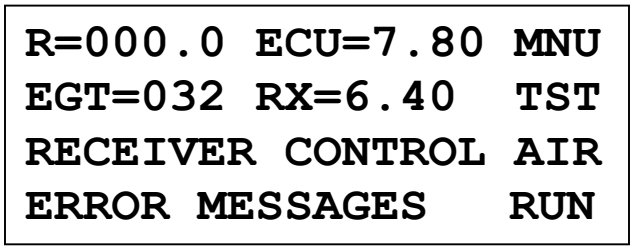
- **Receiver Control Menu**
  - **Ignition On Menu (Receiver Control)**
  - **Fuel Ramp Menu (Receiver Control)**
  - **Running Menu (Receiver Control)**
- **Manual Control Menu**
  - **Ignition On Menu (Manual Control)**
  - **Fuel Ramp Menu (Manual Control)**
  - **Running Menu (Manual Control)**

The **Ignition On Menu** is displayed during the Ignition cycle of the startup sequence. The Ignition cycle is the first cycle after the startup sequence is initiated. The turbine startup sequence is initiated by pressing the “RUN” button in either the Receiver Control Menu or the Manual Control Menu or by moving the throttle up/down three times when using Receiver Control.

The **Fuel Ramp Menu** is displayed during the fuel ramp cycle of the startup sequence. The Fuel Ramp cycle is started after an EGT temperature rise is detected in the Ignition.

The **Running Menu** is displayed during the running cycle after the idle RPM (**LOW RPM**) is achieved in the Fuel Ramp Cycle.

Receiver Control menu



The **Receiver Control Menu** is used to startup/run the engine using the transmitter/receiver. The menu displays the current RPM **(R**) in thousands/hundreds, **EGT** temperature in degree C, ECU battery voltage (**ECU**) in volts, and receiver battery voltage (**RX)** in volts, and **error messages** (if any).

You will not be able to start the engine if any of the error messages are displayed. Below is a list of error messages that may be displayed and only one error message will be displayed at a time. The error conditions for the error messages are checked in the order that they are listed. If an error message is displayed, none of the error conditions for the messages preceding it (in the list) will be present. If the **"RECEIVER BATTERY LOW"** message is displayed, then it can be assumed that the ECU battery voltage is higher or equal to the limit setting, the plug is good, the receiver is turned on, and the receiver battery voltage is higher than or equal to the voltage limit setting.

IMPORTANT NOTE – the error messages displayed in the **Receiver Control Menu** and the **Manual Control menu** are errors that keep you from starting the engine. Errors that occur while the engine is trying to start up or in running, are displayed in the **Operator Setup Menu**.

Whenever there is an error message displayed in the **Receiver Control Menu** or the **Manual Control Menu**, the red LED on the ECU will be flashing. The green LED will be flashing if there are no errors and you will be able to initiate the start sequence.

Receiver Control Menu Error Messages

"**ECU BATTERY LOW**" – This message indicates that the ECU battery voltage is lower than the limit set in the **Operator Parameter Settings Menu**. This is a safety feature that makes sure that the ECU battery voltage is high enough to control the engine during the flight. It is up to the operator to set the voltage limit he or she is comfortable with. We are recommending that this limit be set at 7.2 volts.

"**PLUG OPEN**" - This message indicates that the plug is either bad or the plug cable is not connected to the plug and or the ECU.

"**RECEIVER BATTERY LOW**" – This message indicates that the receiver is either turned off, the ECU receiver cable is not connected properly, or the receiver battery voltage is lower than the limit set in the **Operator Parameter Settings Menu**. This is a safety feature that makes sure that the receiver battery voltage is high enough to control the plane during the flight. It is up to the operator to set the voltage limit he or she is comfortable with. This voltage will depend on the battery pack used and the operator preference.

"**NO RX SIGNAL**" – This message indicates that the ECU is not receiving a signal from the receiver. This probably means that the transmitter is not turned on.

"**SET THROTLE LOW**" – This message means that the ECU is not measuring the correct pulse width for low throttle from the receiver. The transmitter throttle control is either not set at low throttle or the transmitter Teach Procedure needs to be done. Make sure the transmitter is not set for throttle cut (low throttle trim setting). The throttle must be at Low for turbine startup.

"**THROTLE AT CUT**" – This message also means that the throttle is not at low but also is an indicator that the throttle is specifically at the cut setting. This extra information can be used as a sanity check that the teach process has been performed correctly and that the engine can be shut off in an emergency.

"**THROTLE AT HI**" – This message also means that the throttle is not at low but also is an indicator that the throttle is specifically at the hi setting. This extra information can be used as a sanity check that the teach process has been performed correctly and that the engine will respond to throttle commands correctly.

Receiver Control Menu Control Buttons

MNU – The **MNU** button is pressed to go to the **Operator Setup Menu**, which is the next of the three high level menus.

TST – The **TST** button is pressed to select the test to be performed when button #3 is pressed. Each time the **TST** button is pressed, the three letter test type identifier next to button #3 will change to identify the test to be preformed when button #3 is pressed. The three letter test identifiers and a description of the test to be performed are described as follows:

> **AIR TEST** – When **AIR** is displayed to next to button #3, power will be applied to the start motor as long as the button is pressed. This feature can be used to check for proper operation of the starter motor and the RPM measurement system before starting engine. The RPM reading should be greater than 5K RPM with the starter motor running and the ECU battery charged.
>
> While the **AIR** button is pressed a number will be displayed in the lower left corner of the Start/Data Terminal. This number is the signal level from the RPM sensor. See the detailed description of the **"IGN-SENSOR LOW"** error code in the **Operator Setup Menu Error Messages** section for details of this reading.
>
> The **Air Test** is not needed to cool the engine down since the cool down cycle is automatic. Any time the EGT reading is over 150 deg. c, the starter motor will automatically cycle the starter motor until the EGT reading is below 150 deg. C

PMP TEST – When "**PMP"** is displayed next to button #3, power will be applied to the fuel pump as long as the button is pressed. The fuel solenoid will also be activated at the same time. The voltage supplied to the fuel pump during this test is the **PRIME PUMP V** parameter value, which is set in the **Operator Parameter Settings Menu**. This test useful to make sure the fuel pump and solenoid are working and to prime the fuel system. If you want to test to see if the fuel solenoid is operating (feel or hear the solenoid actuating) without pumping fuel, you can unplug the fuel pump temporarily.

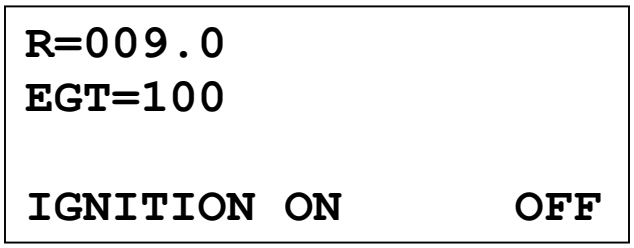
The fuel system MUST be primed and the fuel lines filled with fuel for the Auto Start sequence to work smoothly. BE CAREFUL not to pump fuel into the engine for more than a few seconds, as this will create a fire in the engine when the Auto Start sequence is initiated. If there is any doubt that excess fuel has been pumped into the engine, turn the engine facing down and rotate the engine by hand. Fuel will flow out if there was excessive fuel. Turn the engine facing up and then facing down (rotate again) several times to make sure all the excess fuel has been removed.

GLO TEST– When "**GLO"** is displayed next to button #3, power will be applied to the glow plug for the same time duration that is used during engine startup, each time the button is pressed and held down. The plug voltage will be the **GLOW PLUG V** parameter value, which is set in the **Operator Parameter Settings Menu**. The plug can be removed from the engine while leaving the leads connected to view the brightness of the plug. The plug will be powered only for about ½ second and needs to be almost a white color at the end of the ½ second period.

GAS TEST– When "**GAS"** is displayed next to button #3, power will be supplied to the gas solenoid as long as the button is pressed. The gas flow for the test will be the same gas flow used during the engine startup which is the **GAS ADJUST** parameter value set in the **Operator Parameter Settings Menu**. You will be able to feel or hear the solenoid pulsing as well as observe gas moving in the gas lines. If the gas line is removed from the engine, there will be gas vapor emitting from the gas line.

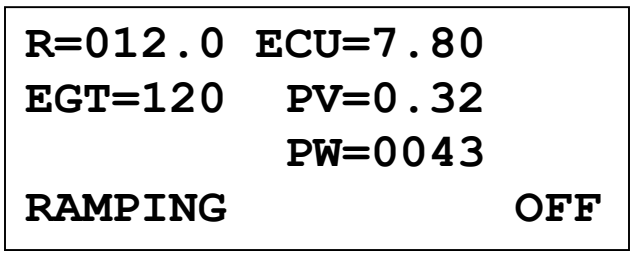
RUN – The **RUN** button is pressed to start the Auto Start sequence to run the engine.
The Auto Start sequence can be initiated by pressing the **RUN** button or moving the transmitter throttle stick from low throttle, to high throttle, and back to low throttle three times while in the **Receiver Control menu**. This eliminates the need for using an extra channel on the receiver. When the Auto Start sequence is initiated the Ignition On menu will be displayed first.

Ignition On Menu (Receiver Control)



The **Ignition On Menu** is displayed when the Auto Start sequence is started and shows the status of the engine during the ignition cycle. During the Ignition On cycle, voltage is applied to the glow plug, the gas solenoid is opened to feed propane/butane to the engine, and the starter motor is turned on. The engine RPM (**R**) and **EGT** temperature will be continuously monitored and displayed. Pressing the **OFF** button will terminate the Auto Start sequence. The engine will be shut down but no error message will be displayed in the **Operator Setup Menu** for this manual shutdown. If the Transmitter is set to throttle cutoff (low throttle trim), the Auto Start sequence will terminate, and an error message will be displayed in the **Operator Setup Menu**. When the RPM has increased to at least 5K rpm and the EGT temperature has increased by at least 8 deg. c, the Ignition cycle will end and the Fuel Ramp cycle will start. The **Fuel Ramp Menu** will then be displayed.

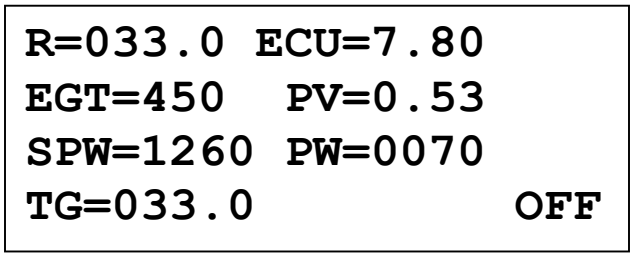
Fuel Ramp MENU (Receiver Control)



The **Fuel Ramp Menu** is displayed during the fuel ramp cycle of the Auto Start sequence and shows the engine status during the Fuel Ramp cycle. The engine RPM (**R**), **EGT** temperature, Pump Voltage (**PV**) and pump pulse width (**PW)** are continuously displayed. Pressing the **OFF** button will stop the engine Auto Start sequence. The engine will be shut down but no error message will be displayed in the **Operator Setup Menu** for this manual shutdown. If the Transmitter is set for throttle cutoff (low throttle trim), the engine will shut down and an error message will be displayed in the **Operator Setup Menu**. The pump voltage (**PV**) will start at the **START PUMP V** value and will gradually increase based on RPM

and EGT temperature readings during the Fuel Ramp cycle. The **START PUMP V** can be set in the **Operator Parameter Settings Menu**. If this value is low, it will take a longer time for the fuel flow to start causing an increase in the engine RPM and if this value is high, the fuel will start with too much flow at the start and cause a hot start (too much fuel for a given RPM). When the engine RPM reaches the idle (**RPM LO**) rpm, the Fuel Ramp cycle will end and the Running cycle will start. The Running menu will then be displayed.

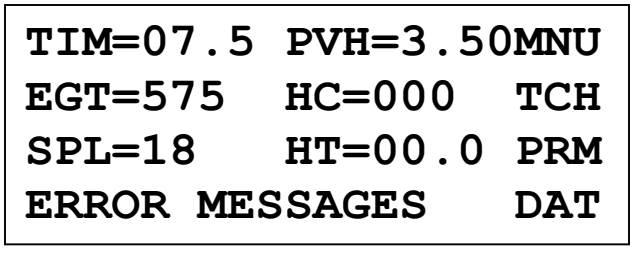
Running Menu (Receiver Control)



The Running menu is displayed during the normal running cycle after the Auto Start sequence is completed. **R** is the actual current engine rpm. **ECU** is the current ecu battery voltage. **EGT** is the current engine EGT temperature in deg. c. **PV** is the current pump voltage. **PW** is the actual pw of the pwm signal to the fuel pump. **SPW** is the current pulse width coming from the receiver throttle servo output.
TG is the target rpm which represents the current desired rpm based on the receiver throttle signal (throttle stick position).

Pressing the **OFF** button will shut the engine down but no error message will be displayed in the **Operator Setup Menu** for this manual shutdown. If the Transmitter is set for throttle cutoff (low throttle trim), the engine will shut down and the message **"RUN-TX SHUTDN"** will be displayed in the message area of the **Operator Setup Menu**.

Operator Setup Menu



The Operator Setup menu is used to display data from the last engine run, display any error messages from the last engine run, and to access other setup menus by depressing the appropriate control button. Data displayed from the last run include **TIM** (engine run time in minutes), **EGT** (maximum **EGT** temperature

in deg. c), **SPL** (engine spool down time in seconds), **HC** (number of fail safe hits), and **HT** (total time in fail safe mode).
If the engine failed during the Auto Start process or stopped while running, the error message area of the Operator Setup menu will contain the error message describing the reason for the failure.

The error message information is saved in EEPROM and will not be lost if the ECU is turned off or if the battery becomes disconnected in a crash. The error message will be displayed in the message area of the **Operator Setup Menu** until the Auto Start procedure is initiated for the next engine run.

Operator Setup Menu Error Messages

"**IGN-TX SHUTDOWN**" – This message means the Transmitter kill signal (low throttle trim) was detected while in the Ignition cycle of the Auto Start sequence and the Auto Start sequence was terminated. . This message only applies to errors while operating in the Receiver Control mode. This is not really an error in the case when the ECU was intentionally shut down with this method during the Ignition On cycle.

"**IGN-NO RPM**" – This message means than no RPM was detected during the first run-up test during the ignition cycle of the Auto Start sequence and the Auto Start sequence was terminated. This message applies to errors while operating in the Receiver Control mode and the Manual Control mode. This can be checked by running the start motor test (**AIR TEST**), as described in the **Receiver Control Menu Control Buttons** section, while viewing the rpm reading.

"**IGN-LOW RPM**" – This message means that the RPM did not get up to 5K RPM during the first run-up test in the Ignition cycle of the Auto Start sequence and the Auto Start sequence was terminated. This can be checked by running the start motor test (**AIR TEST**), as described in the **Receiver Control Menu Control Buttons** section, while viewing the rpm reading. This message applies to errors while operating in the Receiver Control mode and the Manual Control mode.

"**IGN–NO IGNITION**" – This message means that the EGT temperature rise was not high enough to initiate fuel ramp while in the Ignition cycle of the Auto Start sequence and the Auto Start sequence was terminated. The EGT temperature must raise at least 8deg. C within three seconds after ignition start or the ignition cycle will be terminated. The cause of this error is probably not enough or no glow plug heat to ignite the propane/butane or not enough propane/butane gas flow to build up the engine temperature. The glow plug voltage can be adjusted in the **Operator Parameter Settings Menu** but the nominal value of 1.00 should work if the R8 plug is used. This message applies to errors while operating in the Receiver Control mode and the Manual Control mode.

“IGN–IGNITION TIMEOUT” – This message means that the engine rpm was not over 5K RPM within 4 seconds after ignition was detected while in the ignition cycle of the Auto Start sequence and the Auto Start sequence was terminated.

“IGN–SENSOR LOW” – This message means that the rpm sensor signal level was not high enough during the rpm sensor signal level test of the Auto Start sequence and the Auto Start sequence was terminated. The rpm signal level test is run during the first engine run-up while the engine is at 5K rpm. It is performed to make sure the rpm sensor is working properly before ignition is started.

This signal level can be manually checked in the **Receiver Control Menu** or **Manual Control Menu** by running the **Air Test** and viewing the number in the lower left position of the display while the rpm is up to about 5K rpm. The number is the signal level of the rpm sensor and must be greater than 200 while the rpm is about 5k rpm in order for the sensor signal level test to pass.

If the rpm sensor signal level is less than 200, pass a magnet QUICKLY back and forth across the diameter of the engine front cover at all angles around the circumference and check the signal level again. Repeat this procedure until the reading is over 200.
If this procedure does not work the sensor or the magnet in the nut may be defective.

“**RMP-TX SHUTDOWN**” – This message means the Transmitter kill signal (low throttle and low throttle trim) was detected while in the fuel ramp cycle of the Auto Start sequence and the Auto Start sequence was terminated. This message only applies to errors while operating in the Receiver Control mode. This is not really an error in the case when the ECU was intentionally shut down with this method during the Fuel Ramp cycle.

“**RMP- EGT HIGH**” – This error means that the EGT temperature reached 850 deg. C during the fuel ramp cycle of the Auto Start sequence and the Auto Start sequence was terminated. This message applies to errors while operating in the Receiver Control mode and the Manual Control mode.

“**RMP- MTR TIMEOUT**” – This error means that the engine RPM has not reached the rpm that the start motor is turned off within 30 seconds during the fuel ramp cycle of the Auto Start sequence and the Auto Start sequence was terminated. The start motor is turned off at 30k rpm for the RAM500 and at 2ok rpm for the RAM1000 and RTI2800 engines. This is usually caused by not enough fuel getting to the turbine at a fast enough rate. The fuel system may be clogged, the fuel pump may be weak, the Pump Start Voltage may be too low, the Gas Adjust may be too low, or the start motor may be weak Check the fuel system and fuel pump operation, and make sure that the pump is primed. This message applies to errors while operating in the Receiver Control mode and the Manual Control mode.

"**RMP- RPM DROPPED**" – This error means that the RPM has dropped at least 8k rpm during the fuel ramp cycle of the Auto Start sequence and the Auto Start sequence was terminated. This message applies to errors while operating in the Receiver Control mode and the Manual Control mode.

"**RUN-TX SHUTDOWN**" – This message means the Transmitter cut signal (low throttle trim) was detected while in the running state and the engine was shut down. This message will be displayed after the a normal run with transmitter shutdown using low throttle trim and will not actually be an error in this case. This condition is displayed as an error because if the operator did not set the transmitter low throttle trim, an actual error is recognized. This condition could occur if the signal was lost and the receiver went into the failsafe condition and the failsafe system is not set up correctly. See the **Setting up and Testing the Fail-Safe System** section. This message only applies to errors while operating in the Receiver Control mode

"**RUN- EGT HIGH**" – This error means that the EGT temperature reached 950 deg. C in the running state and the engine was shut down This message applies to errors while operating in the Receiver Control mode and the Manual Control mode.

"**RUN-FAIL SAFE**" – This message means the fail Safe condition was detected while in the running state and the engine was shut down. If the transmitter fail safe is set up correctly, this error means that the ECU has received fail safe signals from the receiver throttle servo output for a set time period before shutdown. This time period **FAILSAFE DELAY** parameter value is set in the **Operator Parameter Settings Menu**. See the **Setting up and Testing the Fail-Safe System** section This message only applies to errors while operating in the Receiver Control mode

"**RUN-RPM LOW**" – This message means that the engine was shut down while in the running state because the RPM dropped down below 20K rpm. This condition can be caused by running out of fuel or by some engine failure causing the rpm to slow down.
A faulty RPM sensor probe or other rpm measurement system error could also cause this error but these were checked during the startup. Look at the **"IGN–SENSOR LOW"** error description for directions on testing the rpm signal. This message applies to errors while operating in the Receiver Control mode and the Manual Control mode.

"**RUN-RPM HIGH**" – This message means that the engine was shut down while in the running state because the RPM reading was over a preset rpm upper limit value. This upper limit value is usually set for 2-3K rpm above the max rpm value of the engine. This error could be caused by a faulty rpm measurement system error or some other error allowing the engine rpm to raise above this safety limit. Look at the **"IGN–SENSOR LOW"** error description for directions on testing the rpm signal.

Operator Setup Menu Control Buttons

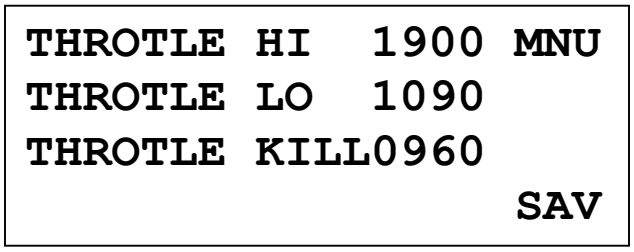
MNU – The **MNU** push button is used to go to the Manual Control Menu.

TCH – The **TCH** (teach) push button is used to go to the transmitter Teach procedure.

PRM – The **PRM** (Parameters) push button is used to go to the Operator Parameter Settings procedure.

DAT – The **DAT** (Data) push button is used to go to the Data menu.

Teach Procedure Menu



The Teach Procedure Menu is used to teach the transmitter the transmitter pulse width values for hi throttle, low throttle, and KILL (low throttle with low throttle trim) to the ECU. When teaching the HI throttle and Low throttle positions the trim can be set either the Hi position or Mid position**. I recommend always leaving the trim set at Hi position** except for the throttle kill. Whichever position you choose for the throttle trim (Hi or Mid), you must **ALWAYS** use this position (except for throttle kill) for the Teach process and when running the engine.

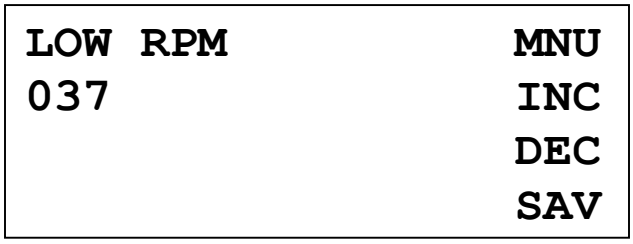
When first entering the procedure, only the top line for "**THROTLE HI"** will be displayed. With the transmitter on, move the transmitter throttle to the high position with the throttle trim set at either the Hi or center position. The pulse width reading should be around 1900 (1900us or 1.9ms) or 2000 depending on where the trim is set. Press the **SAV** (Save) button to save the setting and the second line for **"THROTLE LO"** will be displayed.

Move the transmitter throttle to the Lo position with the throttle trim at mid or hi position (whichever method you have chosen) and the pulse width reading should be around 1100 or 1200 depending on the trim setting. Press the **SAV** button to save the setting and the third line for "**THROTLE KILL"** will be displayed.

Keep the transmitter throttle at the LO position and move the throttle trim to the Lo position for the KILL signal. The transmitter pulse width reading should be around 100 to 200 below the value for the previous Lo throttle reading. The difference will be greater if the Hi throttle trim method is used. The difference should be at least 75 for safety margin. Press the **SAV** button to save the setting and the ECU will return to the **Receiver Control Menu**.

When the Teach Procedure is first entered with the "**THROTLE HI"** message displayed on the first line, the transmitter pulse width can be viewed to check the transmitter pulse width output values for the various throttle and throttle trim positions. The **MNU** can then be pressed to get out of the Teach Procedure without saving any teach parameters. The ECU will return to the **Receiver Control Menu**. Once the first Hi Throttle reading is saved you must continue to press the **SAV** button until the Teach Procedure is completed and the ECU has returned to the **Receiver Control Menu**. You can then go back to the **Teach Procedure Menu** and either view the transmitter pulse widths or re-teach the transmitter pulse width values to the ECU.

Operator Parameter Settings Menu



The Operator Parameter Settings menu is used to modify some of the engine the parameters if desired. The parameter name is displayed in the upper left corner (LOW RPM for example) and the current value for the parameter is displayed directly below.

Operator Parameter Settings Menu Control Buttons

MNU – The **MNU** button is used to go to the next parameter and after the last parameter, to the next menu (**Receiver Control Menu**). The operator can sequence through each of the parameters and then to the **Receiver Control Menu** without making any changes.

INC – The **INC** (increment) button is used to increment the value of the parameter. Each time the button is pressed, the parameter value will increase by 1. If the button is held down the parameter value will increase at a fast rate.

DEC – The **DEC** (decrement) button is used to decrement the value of the parameter. Each time the button is pressed, the parameter value will decrease by 1. If the button is held down the parameter value will increase at a fast rate.

SAV – The SAV (save) button is used to save the new parameter value in EEPROM memory before going on to the next parameter. If the operator forgets to save the new parameter value, he or she must go through the whole set of parameters, exit the procedure, and then come back into the Operator Parameter Settings menu and change/save the parameter again.

Operator Parameter Settings Menu Parameters

LOW RPM – The LOW RPM parameter is the rpm value for low throttle or idle . The operator will not be able to decrement the value to a lower value than a minimum value based on the engine type to insure proper engine running.

HI RPM – The HI RPM parameter is the rpm value for high throttle. The high throttle rpm can be set up to a maximum value based on the engine type. This maximum value is shown in the **Data Menu**. The operator will not be able to increment the value to a higher value than the maximum value.

GLOW PLUG V – The GLOW PLUG V parameter is a number that programs the voltage to the glow plug. The nominal value of 1.00 volts is a good value for the R8 glow plug. Other glow plugs such as the McCoy9 will require a lower voltage. See the "**GLOW TEST**" description in the Receiver Control Menu Control Buttons section.
NOTE: A higher number will set the plug voltage higher.

ECU BATTERY LIMIT – If the ECU battery voltage falls below the ECU BATTERY LIMIT parameter value, the Auto Start sequence can not be initiated and the error message **"ECU BATTERY LOW"** will be displayed in the **Receiver Control Menu** and the **Manual Control Menu**. The nominal value for this parameter is 7.20 volts.

RX BATTERY LIMIT – If the RX (receiver) battery voltage falls below the RX BATTERY LIMIT parameter value, the Auto Start sequence can not be initiated and the error message **"RX BATTERY LOW"** will be displayed in the Receiver Control menu. The nominal value for this parameter is 6.30 volts. This receiver voltage limit value should be reviewed and set by the operator to match the voltage of the receiver battery pack and the preference of the operator.

START PUMP V – The START PUMP V (start pump voltage) parameter is the value of the pump voltage at the beginning of the Fuel Ramp cycle. The optimum value for this parameter depends mainly on the strength of the pump.

Some pumps are stronger than others. The value is different for each engine type and pump type. The nominal value for the RAM 1000 and RTI2800 is 0.32 volts and 0.4 for the RAM 500. IF the value is lower than the optimum, it will take longer for the fuel to flow to the engine and the engine may not keep running on the propane alone.
If the value is greater than optimum, the fuel flow will be too much at the start of the Fuel Ramp cycle and a hot start may occur. It is better to have the value a little low and have a short period before the fuel starts affecting the RPM than to have a hot start. The PV (pump voltage) is displayed on the display during the ramp cycle and the running cycle.
Most pumps will allow a smooth startup using the nominal value and only very weak or strong pumps will require a different Start Pump V for a smoother startup.

HINT – Record the Pump Voltage at Idle (RPM LOW) after the turbine is running and set the Start Pump Voltage operator parameter to a value about 0.1 volts lower than the Idle pump voltage for future starts. This is the best way to get smoother starts especially with weak or strong pumps.

GAS ADJUST – The Gas Adjust parameter is a number that programs the amount of gas through the gas solenoid during startup and the same value is used for the **GAS TEST**. The value is adjustable between 0 and 10 with 0 being the least amount and 10 being full on. The nominal value of 6 is a good average value and is equivalent to setting the gas adjust on the RAM ECU to 40.
See the **GAS TEST** description in the **Receiver Control Menu Control Buttons** section. The number may need to be set higher for cold weather and lower for hot weather. If the value is too high there will be flames out the back of the engine and if it is set too low there will not be enough energy to allow for good ramp up in the allotted time.
NOTE: A higher number will produce a larger amount of gas.

PRIME PUMP V – The PRIME PUMP V (prime pump voltage) parameter is the value of the voltage supplied to the pump when running the **PUMP TEST.** See the **PUMP TEST** description in the **Receiver Control Menu Control Buttons** section. This value can be adjusted up or down to increase or decrease the fuel flow during the prime operation. If the value is set too high, it may be difficult to stop the fuel flow to the engine in time to keep excess fuel out of the engine during the prime operation.
The PRIME PV can also be set to the same value as the **Start Pump V** to see if the pump is working at the same value it will see at the start of the Fuel Ramp cycle by running the **PUMP TEST**.

FAILSAFE DELAY – The FAILSAFE DELAY parameter is the value of the delay time between when the ECU detects the Fail Safe Condition and when the ECU shuts the engine down. The value is adjustable between 0.0 sec and 25.5 seconds. The AMA Turbine rules state that the time between when failsafe is

detected and the ECU shuts the engine down is a maximum of 2.0 sec. The default value for the failsafe delay is 2.0 sec.
See the **Setting up and Testing the Fail Safe System** section for a detailed description of the failsafe system.

UP and DOWN TIME PARAMETER ADJUSTMENTS

One of the main functions of the ECU is to control the rate of increase of rpm while going up in rpm and the rate of decrease of rpm when coming down. The rate of increase or decrease is greatly dependent on the rpm range the engine is in at any given time. At low RPM's the rate of increase/decrease has to be much slower than at higher RPM's. There are many algorithms and parameters in the control software to control the rate of rpm increase/decrease. The next 6 operator settable parameters allow the operator to slow the rate of increase/decrease of rpm in case the engine is not operating correctly or quitting with the normal UP/DN parameters. For instance the up/dn times may have to be increased to slow the rate of rpm change at a high altitude. Sometimes it is possible to determine the rpm range that the problem is occurring by watching the RPM reading on the display.

UP HI TIME–The UP HI TIME parameter controls the rate of increase in rpm in the high 1/3 rpm range going up. The value can be set between 100 and 255. The default value is 100 and represents 100% of the normal up time in this region. A setting of 200 would slow the rate of increase in rpm down by ½ in this rpm range. Values less than 100 would speed up the rate of increase in rpm but are not allowed in order to keep a good throttle response with no overshoot.

UP MID TIME–The UP MID TIME parameter controls the rate of increase in rpm in the mid 1/3 rpm range going up. The value can be set between 100 and 255. The default value is 100 and represents 100% of the normal up time in this region. A setting of 200 would slow the rate of increase in rpm down by ½ in this rpm range. Values less than 100 would speed up the rate of increase in rpm but are not allowed in order to keep a good throttle response with no overshoot.

UP LO TIME–The UP LO TIME parameter controls the rate of increase in rpm in the low 1/3 rpm range going up. The value can be set between 100 and 255. The default value is 100 and represents 100% of the normal up time in this region. A setting of 200 would slow the rate of increase in rpm down by ½ in this rpm range. Values less than 100 would speed up the rate of increase in rpm but are not allowed in order to keep a good throttle response with no overshoot.

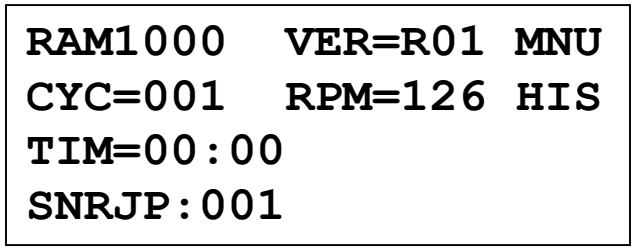
DN HI TIME–The DN HI TIME parameter controls the rate of decrease in rpm in the high 1/3 rpm range going down. The value can be set between 100 and 255. The default value is 100 and represents 100% of the normal down time in this region. A setting of 200 would slow the rate of decrease in rpm down by ½ in this rpm range. Values less than 100 would speed up the rate of decrease in rpm but are not allowed in order to keep a good throttle response with no overshoot.

DN MID TIME–The DN MID TIME parameter controls the rate of decrease in rpm in the mid 1/3 rpm range going down. The value can be set between 100 and 255. The default value is 100 and represents 100% of the normal down time in this region. A setting of 200 would slow the rate of decrease in rpm down by ½ in this rpm range. Values less than 100 would speed up the rate of decrease in rpm but are not allowed in order to keep a good throttle response with no overshoot.

DN LO TIME–The DN LO TIME parameter controls the rate of decrease in rpm in the low 1/3 rpm range going down. The value can be set between 100 and 255. The default value is 100 and represents 100% of the normal down time in this region. A setting of 200 would slow the rate of decrease in rpm down by ½ in this rpm range. Values less than 100 would speed up the rate of increase in rpm but are not allowed in order to keep a good throttle response with no overshoot.

START MOTOR PW–The START MOTOR PW parameter controls the starting PW (voltage) for the start motor at the beginning of engine start up. The start motor PW (voltage) is then incremented slowly during the engine start up. The nominal value for the Start Motor PW is 75 for the RAM 1000 and 50 for the RAM 500.
The parameter has been made adjustable to handle extreme cases when an engine will not come up to 5Krpm during the first run-up for some reason (high pre-load, very cold weather, weak start motor etc.). If this problem occurs, try setting this parameter at 100 and this should solve the problem. This setting can be set=255 to put full battery voltage to the start motor which is needed when using the original start motor on the RAM 750/1000 series motors.

Data Menu



The Data Menu is used to display some of the ECU data and history. The engine model designation (**RAM1000** for example) is displayed in the upper left corner.

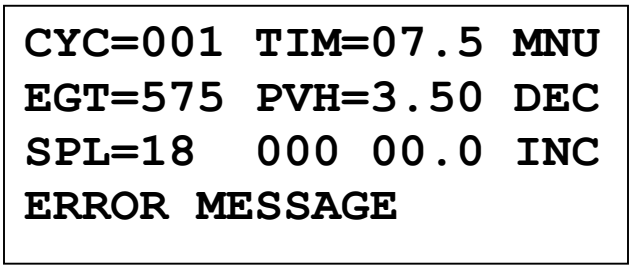
The total number of run cycles is displayed to the right of **CYC=**. The total time (in hrs and minutes) for all the run cycles is displayed is displayed to the right of "**TIM=”**. The serial number of the ECU is displayed at the lower left corner of the display. The version level of the ECU software is displayed to the right of "**VER=**". The maximum RPM that can be set for the engine type is displayed to the right of "**RPM=”**.

Data Menu Control Buttons

MNU – The **MNU** button is used to get back to the **Operator Setup Menu**.

HIS – The **HIS** button is used to go to the **History menu**.

History Menu



The **History menu** is used to view various parameters associated with each prior engine run (cycle). When the menu is first entered the data for the prior engine run will be displayed.
The cycle number will be displayed to the right of **CYC=**. All of the other data will pertain to the engine run of this cycle number, The maximum EGT temperature will be displayed to the right of "**EGT="**. The spool down time (in seconds) will be displayed to the right of "**SPL="**. The run time (in minutes) will be displayed to the right of "**TIM="**. The highest pump voltage will be displayed to the right of "**PVH="**. The failsafe hit count will be displayed just below "**PVH="** and the total failsafe hit Time will be displayed just to the right of the failsafe hit count.

History Menu Control Buttons

MNU – The **MNU** button is used to get back to the Data menu.

DEC – The **DEC** button is used to decrement the cycle number to view the data for earlier runs (cycles).

INC – The **INC** button is used to increment the cycle number.

Manual Control Menu

```
R=000.0 ECU=7.80 MNU
EGT=032 RX=6.40  TST
MANUAL CONTROL   AIR
ERROR MESSAGES   RUN
```

The Manual Control menu is used to run/monitor the engine using the Start/Data Terminal without the need of a receiver/ transmitter. The receiver can still be connected and the receiver can also be turned on if desired. This a convenient way to test run the engine when transmitter frequency is not available or for running on a test bench. The menu displays the current RPM (**R**) in thousands/hundreds, **EGT** temperature in degree c, ECU battery voltage (**ECU**) in volts, and **RX** receiver battery voltage (**RX**) in volts, and **error messages** (if any). You will not be able to start the engine if any of the error messages are displayed. Below is a list of error messages that may be displayed and only one error message will be displayed at a time. The error conditions for the error messages are checked in the order that they are listed. If an error message is displayed, none of the error conditions for the messages preceding it on the list will be present. If the **"PLUG OPEN"** message is displayed, then it can be assumed that the ECU battery voltage is higher or equal to the limit setting.

IMPORTANT NOTE – the error messages displayed in the **Receiver Control Menu** and the **Manual Control menu** are errors that keep you from starting the engine. Errors that occur while the engine is trying to start up or in running, are displayed in the **Operator Setup Menu**.

Whenever there is an error message displayed in the **Receiver Control Menu** or the **Manual Control Menu**, the red LED on the ECU will be flashing. The green LED will be flashing if there are no errors and you will be able to initiate the start sequence.

Manual Control Menu Error Messages

"**ECU BATTERY LOW**" – This message indicates that the ECU battery voltage is lower than the limit set in the **Operator Parameter Settings Menu**. This is a safety feature that makes sure that the ECU battery voltage is high enough to control the engine during the flight. It is up to the operator to set the voltage limit he or she is comfortable with. We are recommending that this limit be set at 7.2 volts.

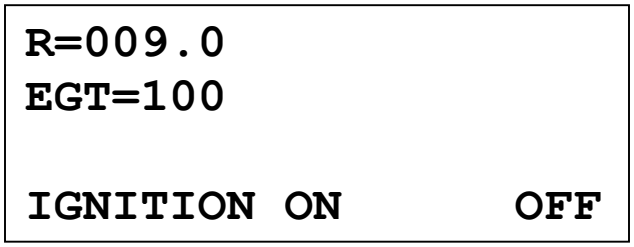
"**PLUG OPEN**" - This message indicates that the plug is either bad or the plug cable is not connected to the plug and or the ECU.

Manual Control Menu Control Buttons

MNU – The **MNU** button is pressed to go to the **Receiver Control Menu.**

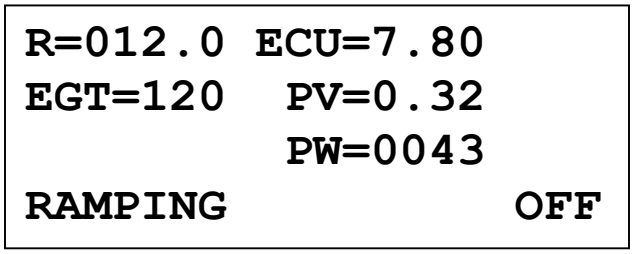
The remainder of the Manual Control Menu Control Buttons including all of the **TEST** functions are the same as described in the **Receiver Control Menu Buttons** section.

Ignition On Menu (Manual Control)



The description of the **Ignition On Menu** for Manual Control is the same as the description of the **IGNITION On MENU** for Receiver Control.

Fuel Ramp Menu (Manual Control)



The description of the **Fuel Ramp Menu** For Manual Control is the same as the description of the **Fuel Ramp Menu** for Receiver Control.

Running Menu (Manual Control)

```
R=033.0 ECU=7.80 INC
EGT=450  PV=0.53 DEC
PWR=LO   PW=0070 FUL
TG=033.0 PVHISET OFF
```

The Running menu is displayed during the normal running cycle after the Auto Start sequence is completed. **R** is the actual current engine rpm. **ECU** is the current ECU battery voltage. **EGT** is the current engine EGT temperature in deg. c. **PV** is the current pump voltage. **PW** is the actual PW of the PWM signal to the fuel pump. **PWR** is the current power setting which is controlled by the **INC**, **DEC**, and **FUL** buttons.
TG is the target rpm which represents the current desired rpm based on the **PWR** (power setting).

Pressing the **OFF** button will shut the engine down but no error message will be displayed in the Operator Setup menu for this manual shutdown. If the Transmitter is set for throttle cutoff (low throttle trim), the engine will shut down and the message “RUN-TX SHUTDN” will be displayed in the message area of the Operator Setup menu.

Running Menu (Manual Control) Control Buttons

INC – The **INC** button is used to increase the power setting (same as increasing the throttle in Receiver mode). The power setting will be “LO” (idle) at the start of the Running Cycle and will be increased by 5% each time the **INC** button is pressed.
The range of values for **PWR** are LO, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and HI. The HI setting is equivalent to hi throttle in the Receiver Control mode.

DEC – The **DEC** button is used to decrease the power setting. The power setting will decrease the power setting by 5% each time the **DEC** button is pressed.

FUL – The **FUL** (full power swing) button will set the power to HI if the current power setting is LO and will set the power setting to LO if the current power setting is HI. If the power setting is not at HI or LO, the **FUL** button will have no effect.

OFF - Pressing the **OFF** button will shut the engine down but no error message will be displayed in the Operator Setup menu for this manual shutdown